Original Article

Neck Lymph Nodes Characterization on Diffusion MRI

Nosheen Ahmad, Asim Shaukat, Shama Aslam, Amna Rehan

ABSTRACT

Objectives: To evaluate the role of Diffusion-Weighted Imaging (DWI) in differentiating the various causes of enlarged neck lymph nodes. **Design:** Prospective study. **Setting:** Department of Radiology Allied Hospital, Faisalabad. **Period:** From July 2013 to December 2013. **Patients and Method:** Thirty four consecutive patients who presented with clinical suspicion of malignant cervical nodes were included in the study, 19 males (55.9%) and 15 females (44.1%). Their age ranged from 45 to 70 years, mean age 56.62 ±7.54 years referred to the radiology department of Allied hospital Faisalabad, complaining of neck swelling, ultrasound showed cervical nodes and all the patients underwent both MRI (T1W, T2W, DWI, ADC) and histopathological examination. **Results:** According to histopathological analysis we divided the examined patients with lymph nodes (n= 34) into 2 categories: malignant lymph nodes 70.6% (n=24) benign lymph nodes 29.4% (n=10). DWI and ADC (apparent diffusion coefficient) values revealed 26 malignant lesions (76.5%), 8 benign (23.5%). The accuracy of the DWMRI was 88.23%. A significant difference between benign and malignant cervical nodes on DWI and on ADC maps is reported. The results obtained were 23 true positive, 3 false positive, 7 true negative and 1 false negative case was identified, yielding a sensitivity of 96%, specificity of 70%, NPV= 87.5% and PPV= 88.5%. The difference between the mean ADC values between benign and malignant lesions was statistically significant (P<0.0001). **Conclusion:** Diffusion-weighted imaging is a valuable tool in the differentiation of benign and malignant lymph nodes.

Key words: Neck Lymph Nodes, Diffusion-Weighted MRI, ADC

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INTRODUCTION

Neck lymph nodes detection and their characterization into benign or malignant has pivotal effect in patients with head and neck cancer for staging, treatment planning and follow-up of cancer. [1]

Small lymph nodes with a maximum short axial diameter below 10 mm are more challenging for radiologists, because the mere use of this size criterion will result in misclassification of malignant lymph nodes as normal on MRI evaluation.[2]

Diffusion-weighted MRI (DWI) is a non-invasive functional technique which allows the characterization of tissues and lesions by difference in microstructure based on the analysis of water motion as architectural changes in the water molecule movement will alter the apparent diffusion coefficient and the signal intensity in DWI and apparent diffusion coefficient maps. The ADC value depends upon the lesion cellularity and the extracellular space.[3]

Hypercellular tissue, such as occurring within malignant tumors, will show low ADC values and appears hypointense on diffusion imaging. Non-tumoral tissue shows low cellularity, as compared with viable tumor. This results in a high ADC. [4]

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The differential diagnosis between benign and malignant lymph nodes is highly dependent on quantitative analysis with ADC calculation. Both benign inflamed and malignant lymph nodes may show an increased but variable SI on DWI native images and low SI on ADC map. Quantitative analysis can be performed by drawing ROIs over the lymph nodes on the separate native b-value images and calculating the ADC from the SI on the consecutive b-value images. [5]

The aim of this study is to define the diagnostic accuracy of DWI to differentiate benign from malignant cervical lymph nodes using histological results as the standard of reference, as there is increasing need for available noninvasive imaging techniques, able to differentiate between benign and malignant lymph nodes

MATERIALS & METHODS

This prospective study was undertaken in Department of Radiology, Allied Hospital, Faisalabad. Study was carried out over a period of six months from July 2013 to December 2013.Thirty four consecutive patients who ranged from 45-70 years, mean age 56.62 ±7.54 years of both gender(19 males 55.9%) and 15 females (44.1%) with enlarged neck lymph nodes clinically suggestive of malignancy were collected from outpatient department of Allied Hospital, Faisalabad. The patients exempted from the study are those with general MRI contra-indications and we excluded the necrotic areas from analysis to avoid a false high ADC due to the low amount of intact tumoral cells.

All the patients were examined with 1.5 Telsa whole body MR imager (DWI and ADC images). For MRI examination standard head and neck coil was used. Conventional images were obtained using T1W, T2W, T1W fat saturated sequence there after underwent DWI with b values (0 and 1000). Apparent Diffusion Coefficient (ADC) maps were automatically generated from DWI by MRI machine software. ADC values were calculated for the enlarged lymph nodes. The MRI protocol included: T1-weighted images (500–600/10 repetition time ms/echo time ms) and T2-weighted fast spin echo images (3000/100) were obtained in the axial, coronal and sagittal planes, with a section thickness of 3–4 mm, an intersection gap of 1 mm, a field of view (FOV) of 250 mm and a flip angle of 90. T1-weighted images with fat saturation were performed. Diffusion-weighted images were obtained in the axial plane 3–4 mm slice thickness, 1 mm intersection gap, FOV 250 mm, repetition time/echo time 2000–2600 ms/70 ms.

The diffusion sensitizing gradient was applied in all three orthogonal planes (X, Y, Z) using b values (0 and 1000 s/mm2). Apparent Diffusion Coefficient (ADC) maps were automatically calculated by MRI machine software extended MR Workspace R1.0 (View Forum R 6.1 V5) software and a workstation.

In each patient, the largest abnormal node was selected for evaluation. The nodal ADC value was obtained by drawing a region of interest (ROI) covering as much as possible of the pathologic node the results were averaged.

Finally, the radiologic findings (ADC values measured on MRI) and the histopathology results were correlated – as a reference standard.

Data was analyzed on SPSS version 17. The mean and standard deviations for ADC values were calculated. Sensitivity (Se), specificity (Spe), positive predictive value (PPV), negative predictive value (NPV), and accuracy of DWI in detecting laterocervical lymph node metastases were calculated.

RESULTS

Age distribution (Mean & SD) (table1)

ADC values of benign lesions ranged between 1.20 . 10_3 and 1.6 · 10_3 mm2/s (Table 2). The mean ADC value of the benign lymph nodes (n=8) was 1.45± 0.14 · 10_3 mm2/s.

ADC values of the malignant lymph (n= 26) ranged between 0.5. 10_3 and 1.10 · 10_3 mm2/s (Table 2). The mean ADC value of malignant lymph nodes was 0.80± 0.15 ·10_3 mm2/s.

Table 1: Patients age distribution

Case diagnosis	Minimum Age	Maximum Age	Mean (SD)
Benign	51	70	56.88(7.92)
Malignant	45	70	56.62(7.54)

The mean ADC value of malignant nodes was lower than the mean ADC value of benign nodes. The difference between the mean ADC values of benign and malignant lesions was statistically significant (P <0.0001).

Table 2: Comparison of ADC values among benign and malignant lymph nodes group

ADC value(· 10^{-3} mm2/s)			
	Range	Mean	SD
Benign	1.2-1.6	1.45±0 .14	0.1397
Malignant	0.5-1.1	0.80± 0.15	0.152

The statistical data obtained were 34 true-positive, 3 falsepositive,7 true-negative,1 false negative findings, yielding 96% sensitivity, 70% specificity%, NPV = 87.5% and PPV= 88.5% (Table 3).

Table 3 ADC-pathology correlation

	Frequency	Percentage(%)
True positive	23	67.65
False positive	3	8.82
True negative	7	20.59
False negative	1	2.94
Total	34	100

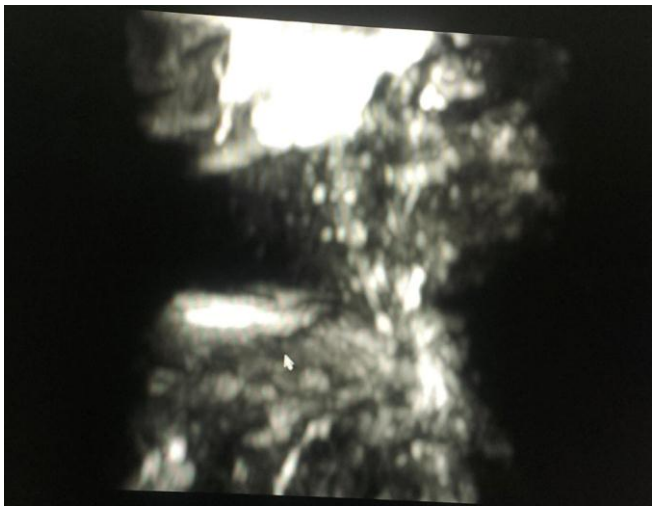

Figure 1(a): Diffusion images acquired through neck showing multiple bilateral enlarged cervical lymph nodes. At DWI, the nodes are of hyperintense signals.

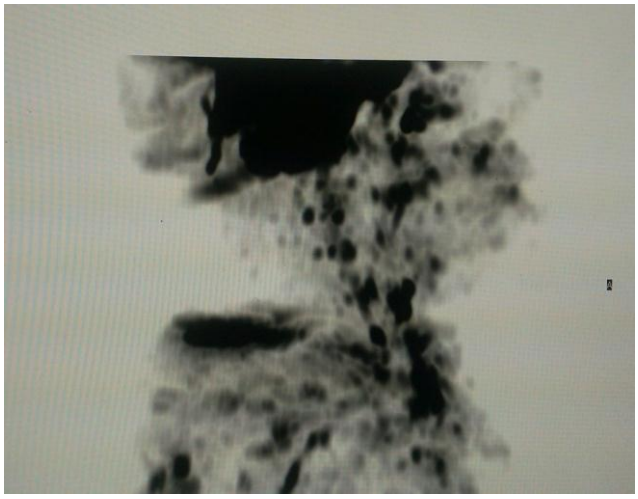

Figure 1(b): Enlarged cervical nodes are of low signal intensity at ADC map

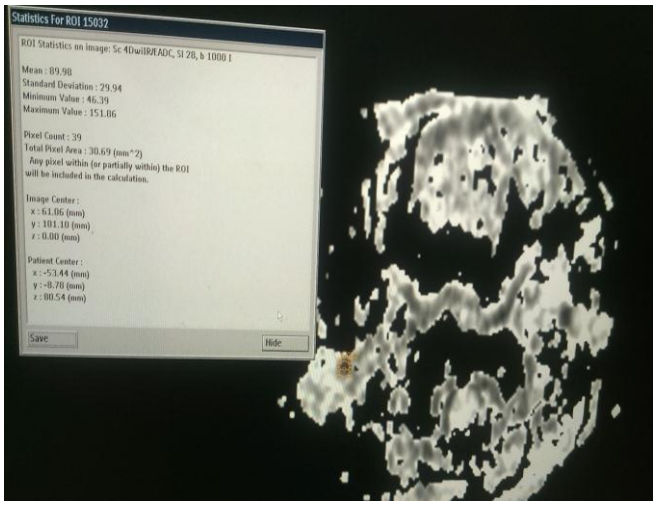

Figure 1(c): ROI applied on right sided cervical node and the ADC value is 0.89 · 10^{-3}mm2/s consistent with malignant nodes

DISCUSSION

Ultrasound image, contrast-enhanced computed tomographic and contrast-enhanced MRI using T1W,T2W images allow the detection of enlarged cervical lymphadenopathies but none of these is able to characterize them with ideal accuracy. [6]

Nowadays there is an increasing role of diffusion-weighted imaging (DWI), which is an evolving noninvasive functional MRI technique that seems to be quite reliable in distinguishing between benign and malignant tissues. [7]

In the detection of sub-centimeter lesions, DWI showed a Se of 76% and a Spe of 94% for the detection of 4–9 mm lymph nodes, while the Se of

conventional imaging was 7% for the detection of these lesions. [2]

Perronea.[4] reported that ADC values of benign lymph nodes were significantly higher than those of malignant LNs, with a P value <0.01 and the mean ADC value for malignant lesions, that was 0.85 · 10–3 mm2/s, which is lower than that of benign LNs, that was 1.448 · 10–3 mm2/s. The best ADC threshold value for distinguishing benign from malignant nodes was 1.03 · 10–3 mm2/s, with a sensitivity of 100% and a specificity of 92.9%.

The best threshold for differentiating malignant from benign lymph nodes was 1.15 · 10–3 mm2/s.[3]

Choi et al.[8] stated that other false-positive readings may be due to restricted diffusion in recent hemorrhage or hematoma. Therefore, DW imaging probably should not be performed directly after biopsy.

Razek et al.[9] found that the mean ADC value of metastatic (1.09±0.11 · 10_3 mm2/s) and lymphomatous (0.97±0.27 10_3 mm2/s) lymph nodes was significantly lower than that of benign (1.64±0.16 · 10_3 mm2/s) cervical lymph nodes (p<0.04).

In our study, all malignant nodes (n = 24) show restricted diffusion evidenced by increased signal on increasing the b-values (b = 1000) and low signal on ADC maps. Our results are in line with Wu LM[10] who concluded that DW MRI performed with ADC values shows significant differences among malignant and benign nodes in cervical lymphadenopathy.

In our study, the difference between the mean ADC values of benign and malignant lesions was statistically significant (P < 0.0001) which was in line with Vandecaveye et al.[2] reported that the mean ADC value derived from the signal intensity across images (ADC b0-1000) of benign lymph nodes was higher than that of malignant LNs and these differences were statistically significant (P<0.0001).

In our study, DWI showed 96% sensitivity, 70% specificity%, NPV = 87.5% and PPV= 88.5% in the differentiation of benign and malignant cervical lymph nodes, our results are comparable with the study of Elsaid NAE et al.[11]

There was some limitation of our study as increasing the b value in order to improve the sensitivity of diffusion, leads to the reduction of the signal-to-noise ratio and that hampers the ADC measurement on the smallest nodes. In the current study, a maximum b value of 1000 s/mm2 was used.

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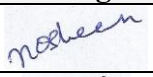
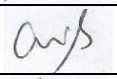
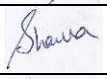
Dr. Nosheen Ahmad	1st Author	
Dr. Asim Shaukat	2nd Author	
Dr. Asim Shaukat	3rd Author	
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